US009880857B2

(12) **United States Patent**
Shen et al.

(10) **Patent No.: US 9,880,857 B2**
(45) **Date of Patent: Jan. 30, 2018**

(54) **SYSTEM FILE MANAGEMENT ON A STORAGE DEVICE**

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(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 33 days.

(21) Appl. No.: **14/956,097**

(22) Filed: **Dec. 1, 2015**

(65) **Prior Publication Data**

US 2017/0153901 A1 Jun. 1, 2017

(51) **Int. Cl.**

G06F 9/44 (2006.01)
G06F 1/00 (2006.01)

(52) **U.S. Cl.**

CPC ***G06F 9/4406*** (2013.01); ***G06F 9/4418*** (2013.01); *G06F 1/00* (2013.01)

(58) **Field of Classification Search**

CPC G06F 17/30091; G06F 21/34; G06F 17/30017; G06F 9/4402; G06F 9/4418; Y10S 707/99939; G06Q 20/3576
USPC 713/2
See application file for complete search history.

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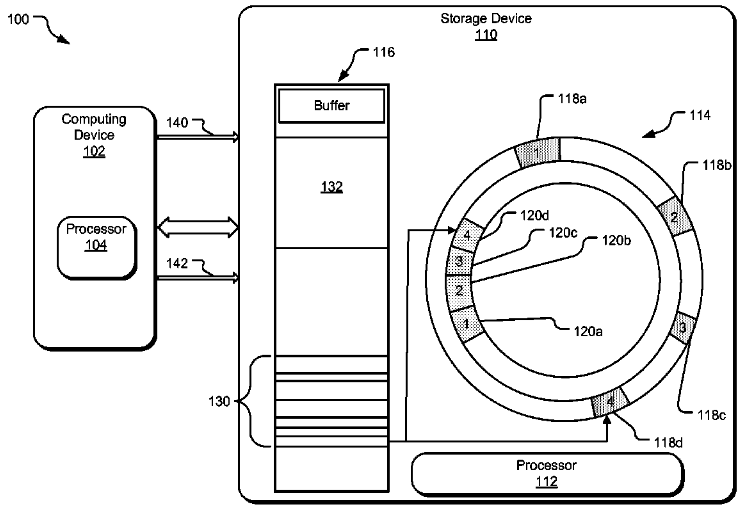
(57) **ABSTRACT**

A method or system comprises reading content of a plurality of system files from storage media of a storage device, generating a master storage device system file, and storing the master storage device system file on the storage media at a master system file location. The location of the master system file is provided to boot firmware or hardware. As a result, when the system boots up, the master system file is read into a temporary cache.

15 Claims, 7 Drawing Sheets



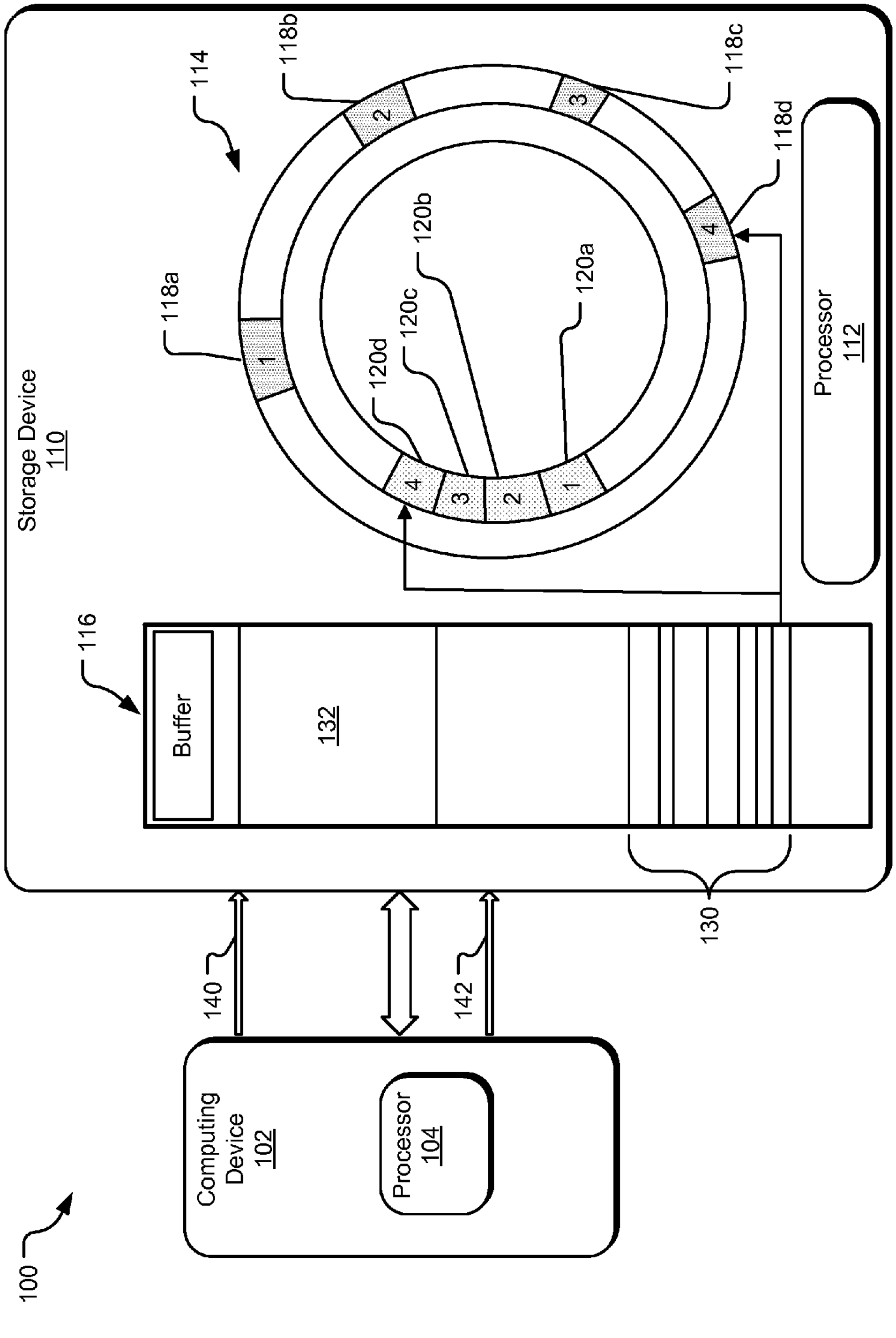

100
Computing Device 102
Processor 104
140
142
Storage Device 110
114
116
Buffer
132
130
118a
118b
118c
118d
120a
120b
120c
120d
1
2
3
4
1
2
3
4
Processor 112

FIG. 1

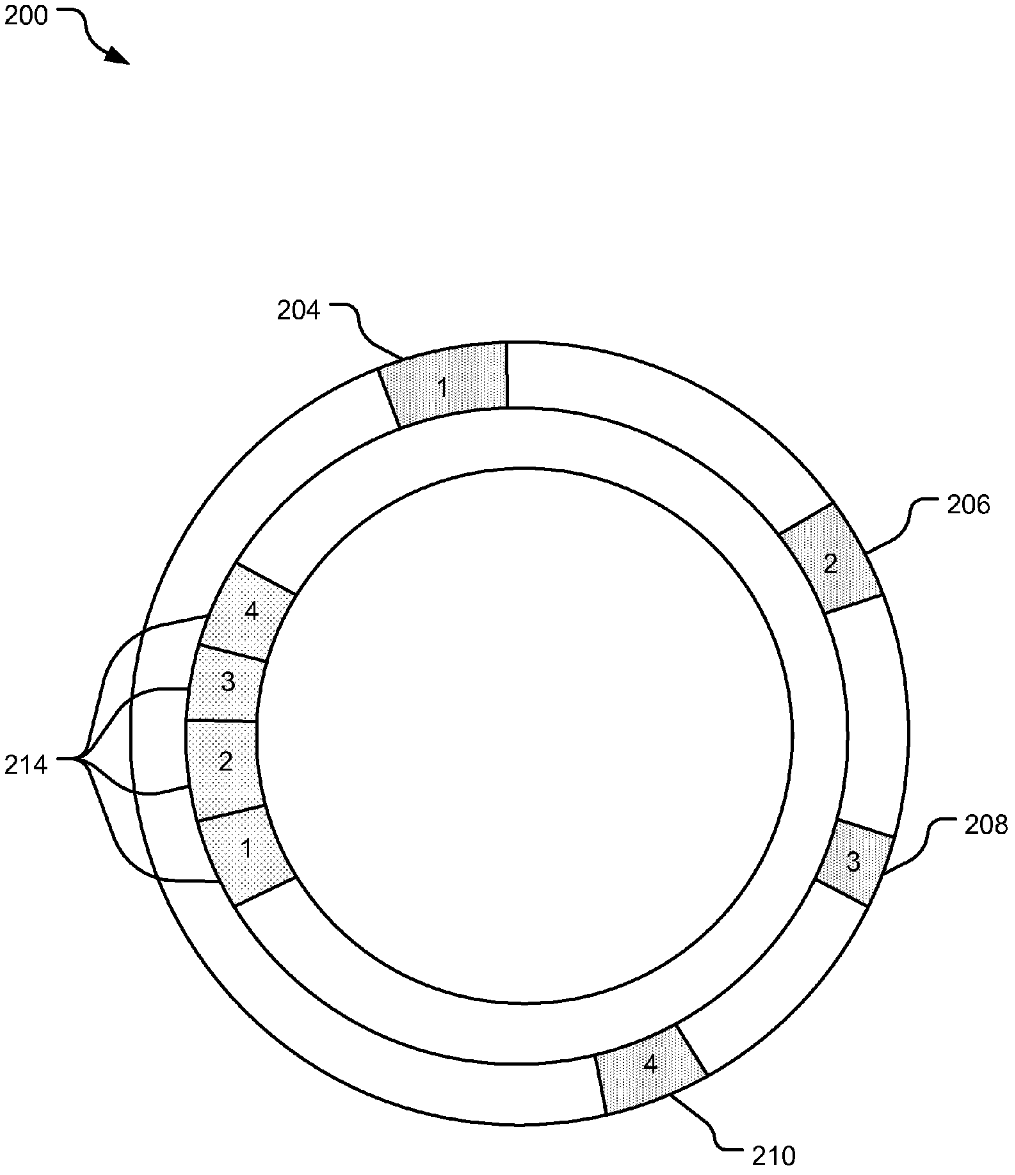


FIG. 2

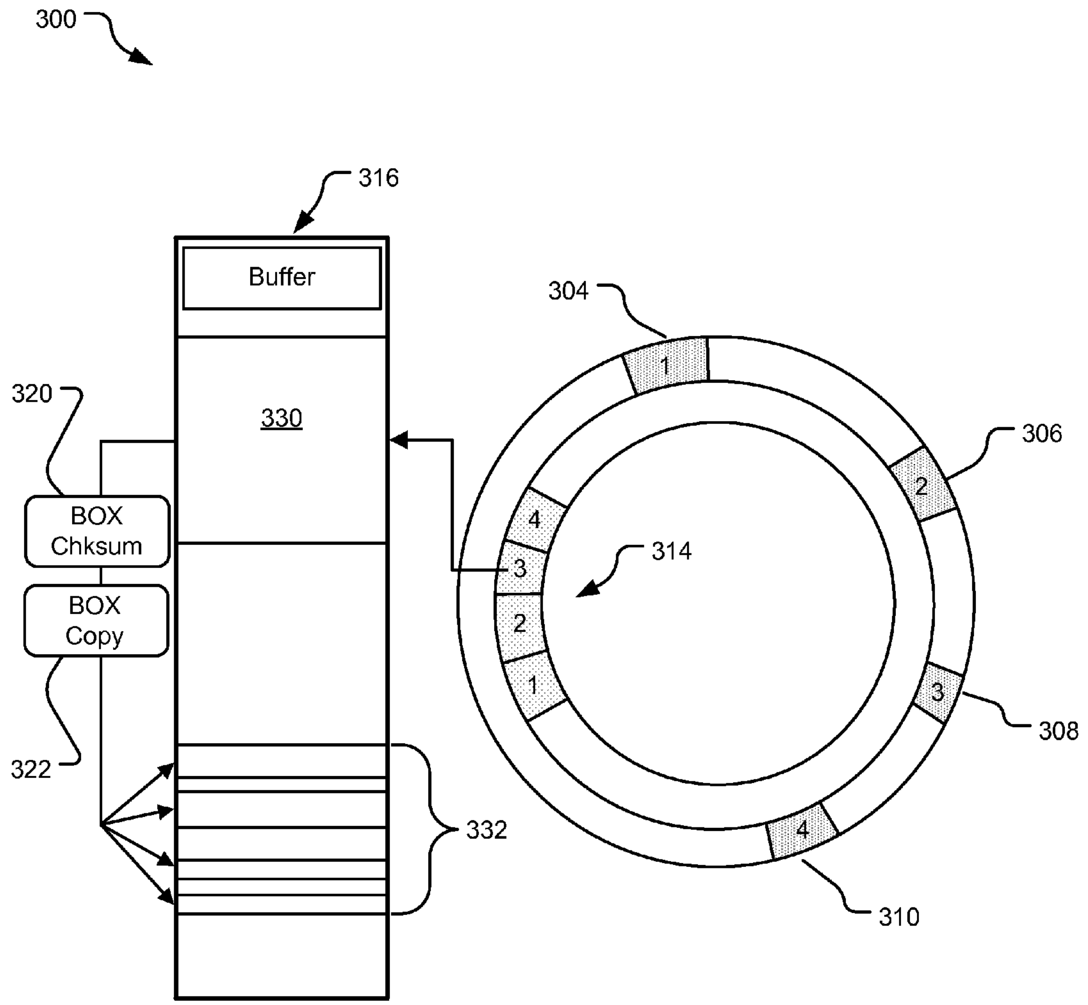

300
316
Buffer
330
304
1
306
2
320
BOX
Chkusm
BOX
Copy
322
4
3
2
1
314
3
308
4
310
332

FIG. 3

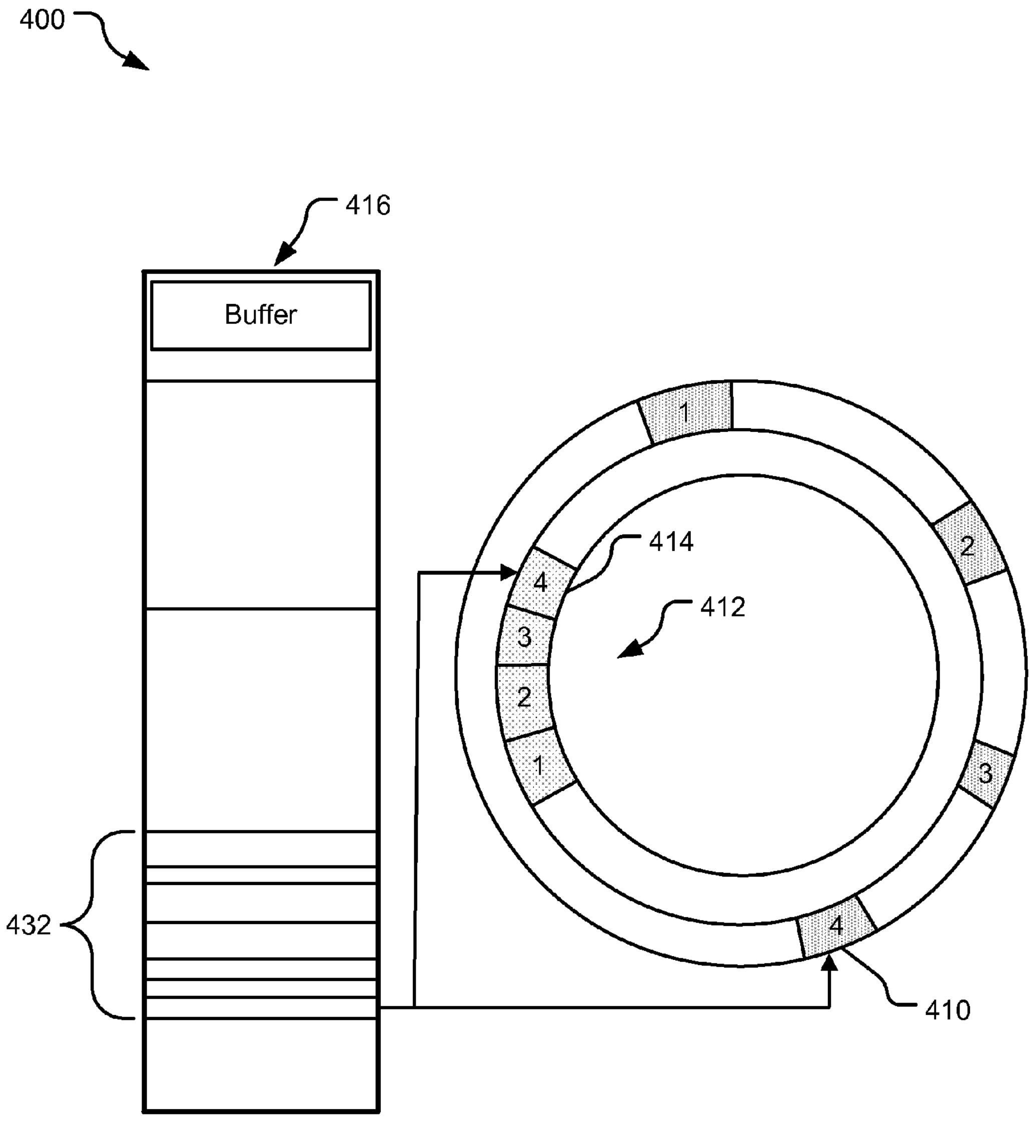


FIG. 4

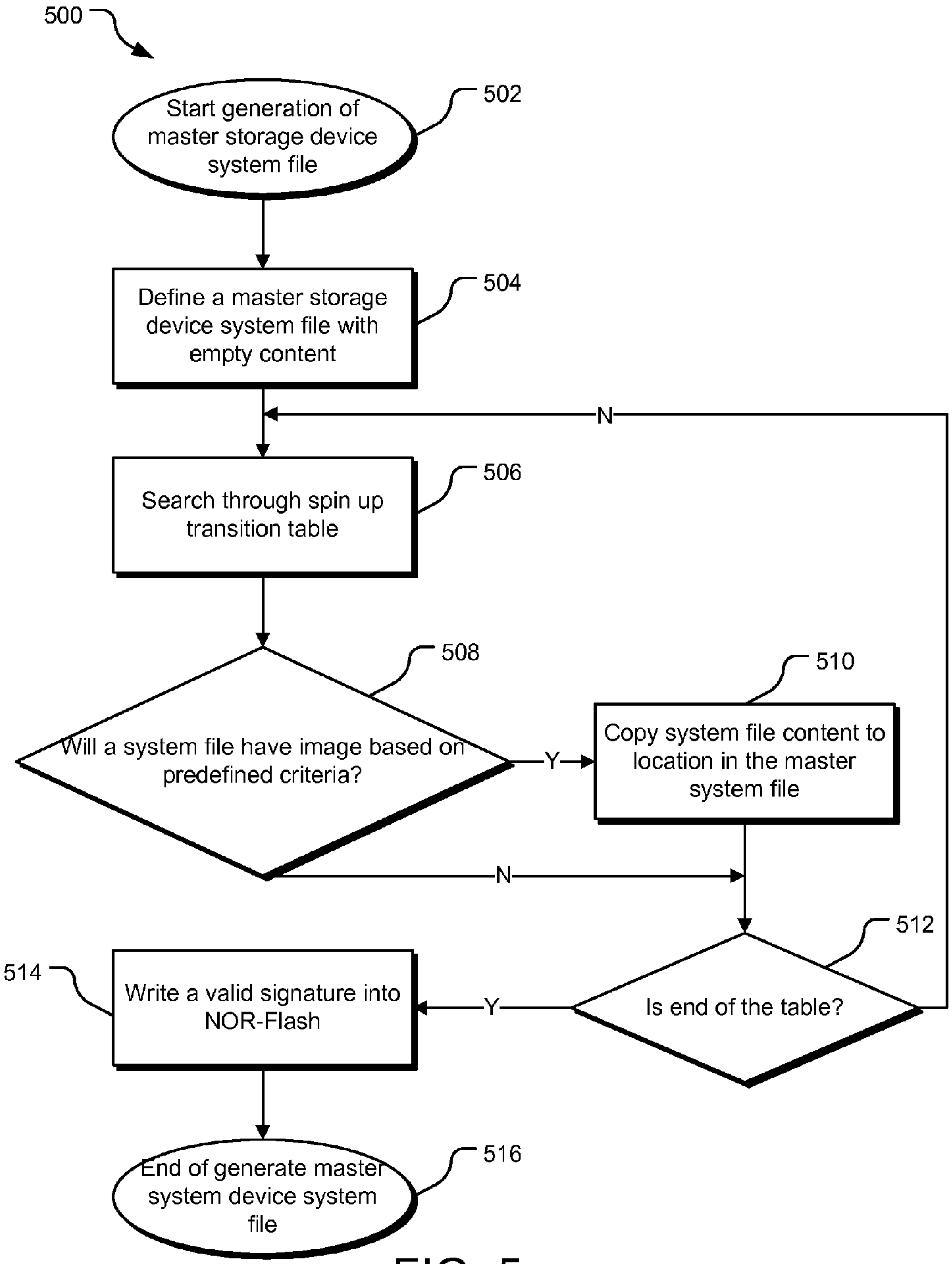

500
Start generation of master storage device system file
502
Define a master storage device system file with empty content
504
N
Search through spin up transition table
506
508
Will a system file have image based on predefined criteria?
Y
510
Copy system file content to location in the master system file
N
512
514
Write a valid signature into NOR-Flash
Y
Is end of the table?
End of generate master system device system file
516

FIG. 5

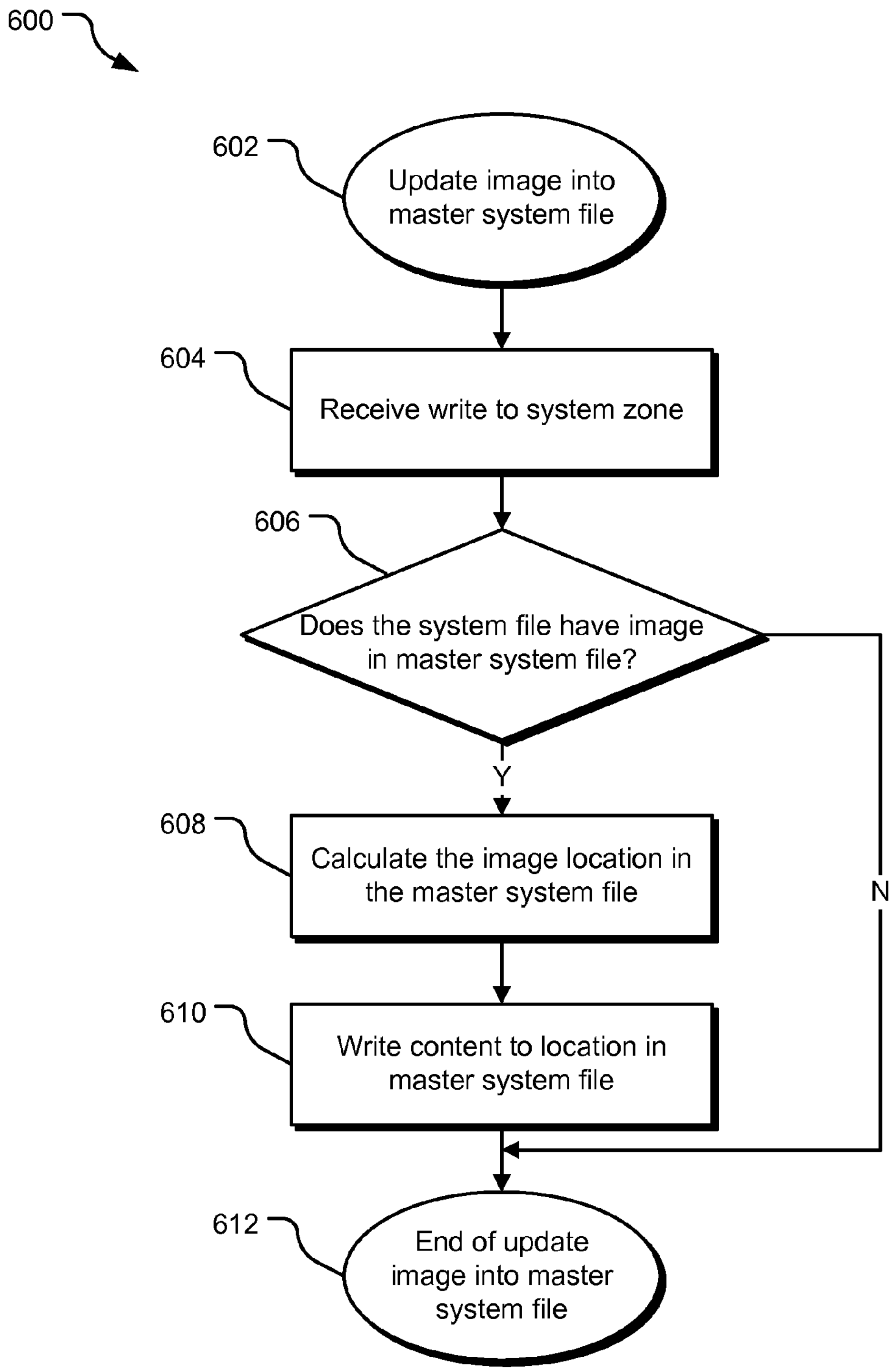

600
602
Update image into master system file
604
Receive write to system zone
606
Does the system file have image in master system file?
Y
N
608
Calculate the image location in the master system file
610
Write content to location in master system file
612
End of update image into master system file

FIG. 6

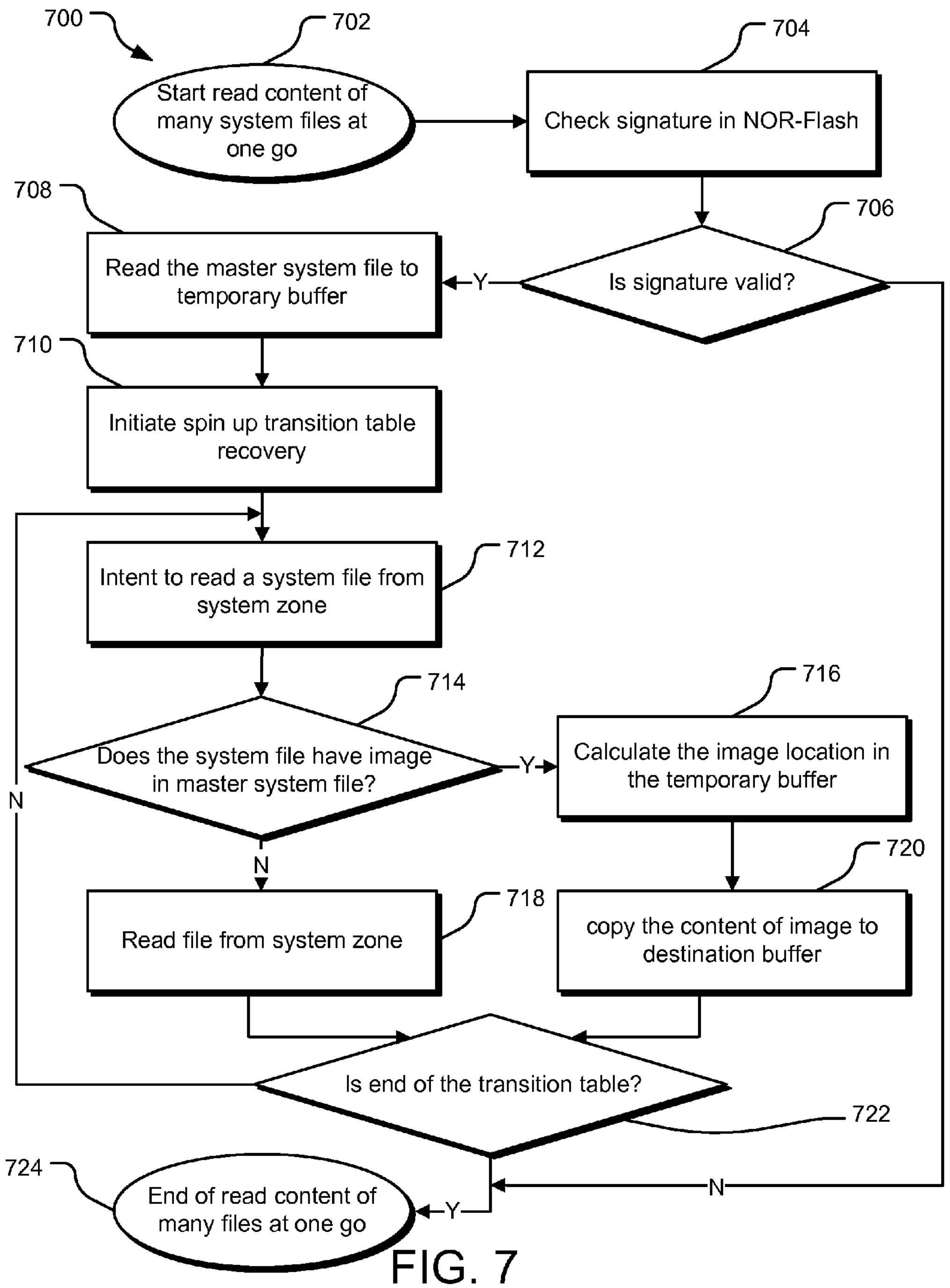

700
702
Start read content of many system files at one go
704
Check signature in NOR-Flash
706
Is signature valid?
Y
N
708
Read the master system file to temporary buffer
710
Initiate spin up transition table recovery
712
Intent to read a system file from system zone
714
Does the system file have image in master system file?
Y
N
N
716
Calculate the image location in the temporary buffer
718
Read file from system zone
720
copy the content of image to destination buffer
722
Is end of the transition table?
724
End of read content of many files at one go
Y

FIG. 7

SYSTEM FILE MANAGEMENT ON A STORAGE DEVICE

BACKGROUND

As the requirements for data storage, retrieval, and analysis has increased, the need for cheaper and faster data storage devices has also increased. Data storage devices, such as disc drives, magnetic tapes, etc., store data on a different recording media using different storage technologies such as magnetic recording, optical recording, etc. Disc drives are widely used as data storage device in computing systems. Disc drives used in embedded systems include many internal files stored in internal storage to support system functions. For instance, in hard disc drives (HDD), there are many system information files, which are stored on a system zone of the HDD. Such files may store information, such as system defects, user defects, direct off scan (DOS), etc. These information is stored in various files that are allocated in system zone on different tracks of the HDD.

SUMMARY

This Summary is provided to introduce a selection of concepts in a simplified form that are further described below in the Detailed Description. This Summary is not intended to identify key features or essential features of the claimed subject matter, nor is it intended to be used to limit the scope of the claimed subject matter. Other features, details, utilities, and advantages of the claimed subject matter will be apparent from the following more particular written Detailed Description of various implementations and implementations as further illustrated in the accompanying drawings and defined in the appended claims.

A method or system comprises reading content of a plurality of system files from storage media of a storage device, generating a master storage device system file, and storing the master storage device system file on the storage media at a master system file location. The location of the master system file is provided to boot firmware or hardware. As a result, when the system bootup, the master system file is read into a temporary cache.

BRIEF DESCRIPTIONS OF THE DRAWINGS

A further understanding of the various implementations described herein may be realized by reference to the figures, which are described in the remaining portion of the specification. In the figures, like reference numerals are used throughout several figures to refer to similar components. In some instances, a reference numeral may have an associated sub-label consisting of a lower-case letter to denote one of multiple similar components. When reference is made to a reference numeral without specification of a sub-label, the reference is intended to refer to all such multiple similar components.

FIG. **1** illustrates an example block diagram of an implementation of a system for management of system files on a storage device.

FIG. **2** discloses an expanded example block diagram of a storage media implementing the technology disclosed herein.

FIG. **3** discloses another example block diagram of a storage media implementing the technology disclosed herein.

FIG. **4** discloses another example block diagram of a storage media implementing the technology disclosed herein.

FIG. **5** illustrates alternative example operations for the system for management of system files on a storage device.

FIG. **6** illustrates yet alternative example operations for the system for management of system files on a storage device.

FIG. **7** illustrates yet alternative example operations **700** for the system for management of system files on a storage device.

DETAILED DESCRIPTIONS

In the following description, for the purposes of explanation, numerous specific details are set forth in order to provide a thorough understanding of the various implementations described herein. While various features are ascribed to particular implementations, it should be appreciated that the features described with respect to one implementation may be incorporated with other implementations as well. By the same token, however, no single feature or features of any described implementation should be considered essential, as other implementations may omit such features.

Computing systems almost invariably use processors working with storage devices where the data used by the processor is stored on the storage devices. Example of storage devices for computing systems use hard disc drives (HDD), flash drives, or other tangible computer-readable storage media. The term “tangible computer-readable storage media” includes, but is not limited to, random access memory (“RAM”), ROM, EEPROM, flash memory or other memory technology, CDROM, digital versatile disks (DVD) or other optical disk storage, magnetic cassettes, magnetic tape, magnetic disk storage or other magnetic storage devices, or any other tangible medium which can be used to store the desired information and which can be accessed by mobile device or computer. In contrast to tangible computer-readable storage media, intangible computer-readable communication signals may embody computer readable instructions, data structures, program modules or other data resident in a modulated data signal, such as a carrier wave or other signal transport mechanism. Note that while the system for management of system files on a storage device is disclosed herein in context of an HDD, one or more aspects the technology disclosed herein may also be applicable to other storage devices enumerated above.

Computing systems often have storage media embedded therein. In embedded system, there are many internal files stored in internal storage to support system functions. When power is turned on for such embedded system, these files are read from internal storage one by one into system memory. Reading these files one by one takes long time so that impacts on time to ready (TTR). For an instance for a computing system with an HDD, there is system information that is stored on a system zone of the HDD. This information includes, for example, system defects, user defects, DOS (direct off line scan), Prizm/Zest etc. This information is stored in various files that are allocated in a system zone on different tracks of the HDD.

When power is turned on in an embedded system using the HDD, a controller of the HDD reads this information from the system zone into HDD memory. Such HDD memory may be implemented using DRAM, etc. A firmware SIM (system information manager) of the HDD controller interprets file locations, which consist of head/cylinder/sector numbers of the files. The HDD controller then issues a command to a servo to seek to file location and then read the file from HDD media to the HDD memory.

When the HDD controller reads each file separately by seeking to each of such files located at different locations within the HDD media, it takes time to seek to these files' media location, then takes one revolution time to read file out of media. For example, when power is turned on for the HDD, it may need to read many files out of disc media, which takes a long time. The HDD is generally unable to accept any host command until it has read all system files from distinct media locations and stored them on the HDD memory.

In one implementation of HDD, the HDD firmware includes a spin-up transition table that contains many entries. Each entry identifying location of an HDD system file and its associated buffer files in the HDD memory. Upon HDD power on, the HDD controller reads various HDD system files to its destination buffer file in the HDD memory. Each file read may require one seek and one revolution to read. As the number of such files increases, the number of seeks and revolutions also increase. This significantly increases the time-to-ready (TTR) of the HDD, which is the time it takes for the HDD to be ready to take host commands after power on.

For computing systems, such as notebooks, the TTR of the HDD (from power on to accept and execute first host command) is important. As more and more system information is added to the system files on the HDD media, it becomes more and more difficult for the HDD to meet the TTR as required by market.

The technology disclosed herein provides system for management of system files on a storage device so as to reduce the TTR. An implementation of such management system provides for reading content of many system files from the HDD media with only one seek and one revolution operation. By doing so, shorter TTR are realized and there is no additional impact on cost. Furthermore, such management system of system files also improves the HDD reliability. In one implementation, the management system constructs a large HDD system file (referred to herein as the "master HDD system file") during run time where such master HDD system file contains the content of many disparate HDD system files. Upon power on of the HDD, the master HDD system file is read in one revolution and copied to a temporary buffer in the HDD memory. Subsequently, the content related to each individual system file is copied from the temporary memory to the target buffer location in the HDD memory.

The master HDD system file is independent of individual HDD system files. As a result, if the master HDD system file is corrupted, the HDD controller can recreate the master HDD system file by reading the content from the individual HDD system files and recreating the master HDD system file, and may store such recreated master HDD system file at a different location in the system memory of the HDD. In effect, the master HDD system file provides redundancy to the individual system files, thus increasing the reliability of the HDD system.

FIG. **1** illustrates an example block diagram of an implementation of a system **100** for management of system files on a storage device. The system **100** includes a computing device **102** communicating with a storage device **110**. The computing device may be, for example, a laptop, a desktop, a sever, a mobile device, a tablet device, etc. In the illustrated implementation, the storage device **110** is shown as being external to the computing device **102**. However, in an alternative implementation, the storage device **110** may be internal to the computing device **102**. The computing device **102** includes a processor **104** and may communicate with the storage device **110** via communication channels **140**, **142**.

The storage device **110** includes a processor **112**, storage media **114**, and a buffer memory **116**. The buffer memory **116** may be volatile memory, such as RAM, etc. The storage media **114** may have a number of system files **118***a*-**118***d* (hereinafter system files **118**) stored in various parts of the storage media **114**. For example, each of the system files **118** may include one or more information about the storage device **110**. A transition table (not shown) located in the firmware of the processor **104** may include information about the system files **118**, such as the location of each of the system files **118**, the functionality of each of the system files **118**, etc.

In the illustrated implementation, the processor **104** includes a computer program to read the content of the system files **118** into a master storage device system files **120***a-d* (master system file **120**). In one implementation, the master system file **120** includes a copy of each of the system files **118**. The master system file **120** may be created during normal operation of the system **100**. For example, the master system file **120** is created during an idle time during the operation of the system **100**. In one implementation, the master system file **120** is stored on a system area of the storage device **110**. Once the master system file **120** is created a valid signature is written into a register of the processor **112**. The operations for creating the master system file **120** are explained in detail below.

During boot up of the storage device **110**, the boot up program of processor **104** checks the appropriate register of the processor **104** to determine if a master system file was created. If it determines that a master system file is created, the processor reads the master system file **120** into a temporary buffer **132**. When the master system file **120** is read during a spin up transition, for each of the system files referred in the spin up table, the processor **104** checks if such system files have an image in the master system file **120**. For example, the spin up table may refer to system files **118***a*, **118***c*, and **118***d*. In such a case, if each of these system files **118***a*, **118***c*, and **118***d* are in the master system file **120**, the processor determines the location of such system files **118***a*, **118***c*, and **118***d* in the temporary buffer **132** and copies them to a destination buffer location **130**.

FIG. **2** discloses an expanded example block diagram of a storage media **200** implementing the technology disclosed herein. The storage media **200** includes a number of system files **204-210**. A master system file **214** including an image of each of the system files **204-210** is stored in a system zone of the storage media **200**.

FIG. **3** discloses another example block diagram of a storage media **300** implementing the technology disclosed herein. The storage media **300** includes a number of system files **304-310**. A master system file **314** including an image of each of the system files **304-310** is stored in a system zone of the storage media **300**. The storage media **300** also includes a buffer **316** including a temporary buffer **330** where an image of the master system file **314** is copied. A hardware copy engine copies each of the system files from the temporary buffer **330** to destination buffers **332** after performing a box checksum **320** and box copy **322**. In such an implementation, the system files **304-310** are not read from the system media to be copied to the destination buffers **332**.

FIG. **4** discloses another example block diagram of a storage media **400** implementing the technology disclosed herein. Specifically, the storage media **400** includes a system file **410** stored on the storage media and a copy **414** of the system file **410** located on a system zone of the storage media as part of a master system file **412**. Copies of the system file **410** may be stored at a destination location **432** on a buffer **416**. If it is determined that a write to storage media may affect the master system file **412**, the copy **414** and the system file **410** are updated using content from the destination location **432**.

FIG. **5** illustrates alternative example operations **500** for the system for management of system files on a storage device. An operation **502** starts generation of a master storage device system file. A defining operation **504** defines the master storage device system file with empty content. For example, the master storage device system file may be defined to be in a system zone of the storage media. An operation **506** searches through a spin up transition table for each of various system files. An operation **508** determines whether a system file will have an image in the master storage device system file. Such decision may be made on one of a plurality of predefined criteria.

If it is determined that an image of a system file is to be created to a master storage device system file, an operation **510** copies the system file from the disc to a location on the master storage device system file. A determining operation **512** determines if there are additional system files. If it is determined that end of the spin up transition table is reached, an operation **514** writes a valid signature into a NOR-flash. The operations for generating the master storage device system file ends at **516**.

FIG. **6** illustrates yet alternative example operations **600** for the system for management of system files on a storage device. An operation **602** starts updating an image of master system file. An operation **604** receives a write to a system zone on a storage device during normal operation of a storage device. An operation **606** determines if the system file has an image in the master system file. If it is determined that the system file has an image in the master system file, an operation **608** calculates the location of an image of the master system file and an operation **610** writes the content of the system file from a buffer to the determined location of the image of the master system file. The operations end at **612**.

FIG. **7** illustrates yet alternative example operations **700** for the system for management of system files on a storage device. At **702** the operations to read content of many system files at one go start. An operation **704** checks a signature in a register or in a NOR-Flash in the storage device processor. If a determining operation **706** determines that the signature is valid, which indicates that a master system file is stored on the storage media, an operation **708** reads the master system file to a temporary buffer.

An operation **710** initiates a spin up transition table recovery. An operation **712** indicates an intent to read a system file from a system zone of the storage device. A determining operation **714** determines if the system file has an image in a master system file. If so, an operation **716** calculates the location of the master system file in a temporary buffer and an operation **720** copies the content of the image of the system file from the temporary buffer to a destination buffer. If the operation **714** determines that there is no image of the system file in the master system file, an operation **718** reads the system file from its location on system zone. If a determining operation **722** determines that it is an end of a transition table, the operations to read content of may system files at one go ends at **724**.

The implementations described herein may be implemented as logical steps in one or more computer systems.

The logical operations of the various implementations described herein are implemented (1) as a sequence of processor-implemented steps executing in one or more computer systems and (2) as interconnected machine or circuit modules within one or more computer systems. The implementation is a matter of choice, dependent on the performance requirements of the computer system. Accordingly, the logical operations making up the implementations of the implementations described herein are referred to variously as operations, steps, objects, or modules. Furthermore, it should be understood that logical operations may be performed in any order, unless explicitly claimed otherwise or a specific order is inherently necessitated by the claim language.

In the interest of clarity, not all of the routine functions of the implementations described herein are shown and described. It will be appreciated that in the development of any such actual implementation, numerous implementation-specific decisions are made in order to achieve the developer's specific goals, such as compliance with application— and business-related constraints, and that those specific goals will vary from one implementation to another and from one developer to another.

The above specification, examples, and data provide a complete description of the structure and use of example implementations. Because many alternate implementations can be made without departing from the spirit and scope of the invention, the invention resides in the claims hereinafter appended. Furthermore, structural features of the different implementations may be combined in yet another implementation without departing from the recited claims.

What is claimed is:

1. A method comprising:

reading content of a plurality of system files from storage media of a storage device, locations of the plurality of system files determined using a transition table containing a plurality of entries, each entry of the plurality of entries corresponding to a system file of the plurality of system files and identifying a location of the system file;

generating a master storage device system file based on the content of the plurality of system files;

storing the master storage device system file on the storage media at a master system file location;

storing, during boot up of the storage device, the master storage device system file to a temporary buffer responsive to determining that the master storage device system file is created; and

copying at least one system file from the temporary buffer to one or more destination buffers responsive to determining that the at least one system file of the plurality of system files includes an image in the master storage device system file stored in the temporary buffer.

2. The method of claim **1**, wherein storing the master storage device system file further comprises storing the master storage device system file on a system zone of the storage media.

3. The method of claim **1**, further comprising providing a location of the master storage device system file to a system on chip (SoC) boot firmware.

4. The method of claim **1**, wherein upon determining that the master storage device system file is not created, reading content from one or more of the plurality of system files.

5. The method of claim **1**, further comprising:

determining a size of the master storage device system file; and determining a location of the master storage device system file based on the size of the master storage device system file.

6. The method of claim **1**, further comprising:

upon receiving a command to write a block to a write destination on a system zone of the storage media:

determining a starting location of the write destination and a length of the block; and

determining if writing the block may overwrite at least a part of the master storage device system file based on the starting location and the length.

7. The method of claim **6**, if writing the block may overwrite at least the part of the master storage device system file, writing the content of the master storage device system file to an alternative image location.

8. The method of claim **1**, further comprising:

determining that a signature is valid, the valid signature indicating that the master storage device system file is stored on the storage media.

9. A storage device comprising:

a storage media, and

a storage controller configured to:

read content of a plurality of system files from storage media of the storage device, locations of the plurality of system files determined using a transition table containing a plurality of entries, each entry of the plurality of entries corresponding to a system file of the plurality of system files and identifying a location of the system file;

generate a master storage device system file based on the content of the plurality of system files;

store the master storage device system file on the storage media at a master system file location;

store, during boot up of the storage device, the master storage device system file to a temporary buffer responsive to determining that the master storage device system file is created; and

copy at least one system file from the temporary buffer to one or more destination buffers responsive to determining that the at least one system file of the plurality of system files includes an image in the master storage device system file stored in the temporary buffer.

10. The storage device of claim **9**, wherein the storage controller is further configured to store the master storage device system file on a system zone of the storage media.

11. The storage device of claim **9**, wherein the storage controller is further configured to provide the master system file location to a system on chip (SoC) boot firmware.

12. The storage device of claim **9**, wherein the storage controller is further configured to:

receive a command to write a block to a write destination on a system zone of the storage media and upon the receipt, determine a starting location of the write destination and a length of the block and determine if writing the block may overwrite at least a part of the master storage device system file based on the starting location and the length.

13. A system comprising:

a storage media configured to store data; and

a storage controller including a processor and tangible computer readable media with computer executable instructions to perform a method of:

reading content of a plurality of system files from storage media of a storage device, locations of the plurality of system files determined using a transition table containing a plurality of entries, each entry of the plurality of entries corresponding to a system file of the plurality of system files and identifying a location of the system file;

generating a master storage device system file based on the content of the plurality of system files;

storing the master storage device system file on a system zone of the storage media at a master storage device system file location;

storing, during boot up of the storage device, the master storage device system file to a temporary buffer responsive to determining that the master storage device system file is created; and

copying at least one system file from the temporary buffer to one or more destination buffers responsive to determining that the at least one system file of the plurality of system files includes an image in the master storage device system file stored in the temporary buffer.

14. The system of claim **13**, wherein the method further comprising providing the master storage device system file location to a system on chip (SoC) boot firmware.

15. The system of claim **13**, wherein the method further comprising determining on execution of a boot sequence whether a master storage device system file is created.

* * * * *